

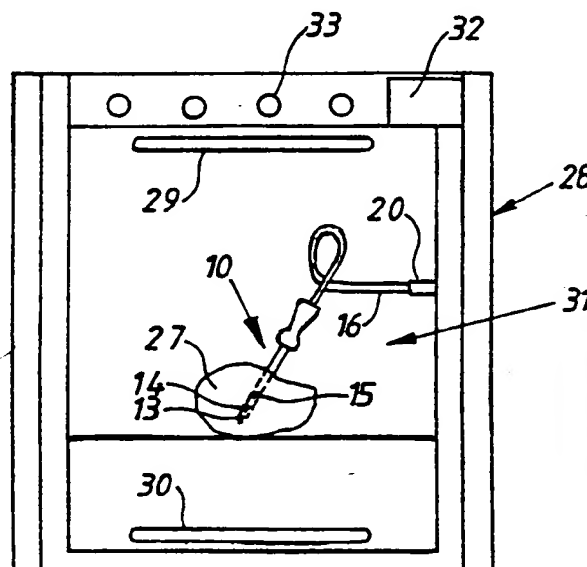


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

|   |           |   |
|---|-----------|---|
| <b>(51) International Patent Classification <sup>5</sup> :</b><br><b>F24C 7/08, G01K 1/00, 13/00</b>  | <b>A1</b> | <b>(11) International Publication Number:</b> <b>WO 93/16333</b><br><b>(43) International Publication Date:</b> 19 August 1993 (19.08.93)   |
| <b>(21) International Application Number:</b> PCT/SE93/00046<br><b>(22) International Filing Date:</b> 22 January 1993 (22.01.93)<br><br><b>(30) Priority data:</b><br>9200371-4      7 February 1992 (07.02.92)      SE<br><br><b>(71) Applicant:</b> AKTIEBOLAGET ELECTROLUX [SE/SE];<br>Luxbacken 1, S-105 45 Stockholm (SE).<br><br><b>(72) Inventors:</b> LJUNGGREN, Per, Henrik ; Hammarvägen 1,<br>S-178 52 EKERÖ (SE). TIMGREN, Roland, Henry ;<br>Basunvägen 22, S-175 48 BROMMA (SE).<br><br><b>(74) Agents:</b> ERIXON, Bo et al.; AB Electrolux, Corporate Pa-<br>tent and Trademarks, S-105 45 Stockholm (SE). |           | <b>(81) Designated States:</b> CA, NO, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).<br><br><b>Published</b><br><i>With international search report.</i><br><i>In English translation (filed in Swedish).</i> |

**(54) Title:** TEMPERATURE PROBE AND OVEN PROVIDED WITH SUCH PROBE**(57) Abstract**

Temperature probe which is intended to be inserted into a foodstuff to be heated and an oven for treatment of foodstuffs including a temperature probe. A temperature probe (10) which is intended to be inserted into a foodstuff (27) to be heated has the shape of a rod and supports, at its tip and at at least one additional position along its length, a temperature sensor (13, 14, 15) of the type the resistance of which varies with the temperature. The temperature probe is connected, via a wire (16), to a connector (20) of the telephone plug type which via a corresponding jack, disposed in an oven (28), is connected to a control device (32) for the control of the heating treatment in the oven. Three temperature sensors (13, 14, 15) are provided in the probe suitably interspaced with respect to one another and the connector (20) is provided with three contact areas (17, 18, 19). The three temperature sensors (13, 14, 15) are connected to form a triangle or to form a star, the three terminals (21, 22, 23; 24, 25, 26) of which being connected to each respective one of the contact areas (17, 18, 19) on the connector (20). The probe is used together with an oven (28) which is provided with a control device (32) of a design such that the treatment process in the oven is controlled in accordance with the lowest one of the temperatures sensed by the temperature sensors.



**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

|    |                          |    |  |    |                          |
|----|--------------------------|----|--|----|--------------------------|
| AT | Austria                  | FR | France                                   | MR | Mauritania               |
| AU | Australia                | GA | Gabon                                    | MW | Malawi                   |
| BB | Barbados                 | GB | United Kingdom                           | NL | Netherlands              |
| BE | Belgium                  | GN | Guinea                                   | NO | Norway                   |
| BF | Burkina Faso             | GR | Greece                                   | NZ | New Zealand              |
| BG | Bulgaria                 | HU | Hungary                                  | PL | Poland                   |
| BJ | Benin                    | IE | Ireland                                  | PT | Portugal                 |
| BR | Brazil                   | IT | Italy                                    | RO | Romania                  |
| CA | Canada                   | JP | Japan                                    | RU | Russian Federation       |
| CF | Central African Republic | KP | Democratic People's Republic<br>of Korea | SD | Sudan                    |
| CG | Congo                    | KR | Republic of Korea                        | SE | Sweden                   |
| CH | Switzerland              | KZ | Kazakhstan                               | SK | Slovak Republic          |
| CI | Côte d'Ivoire            | LI | Liechtenstein                            | SN | Senegal                  |
| CM | Cameroon                 | LK | Sri Lanka                                | SU | Soviet Union             |
| CS | Czechoslovakia           | LU | Luxembourg                               | TD | Chad                     |
| CZ | Czech Republic           | MC | Monaco                                   | TG | Togo                     |
| DE | Germany                  | MG | Madagascar                               | UA | Ukraine                  |
| DK | Denmark                  | MI | Mali                                     | US | United States of America |
| ES | Spain                    | MN | Mongolia                                 | VN | Viet Nam                 |
| FI | Finland                  |    |  |    |                          |

Temperature probe and oven provided with such probe

The present invention pertains to a temperature probe of the kind indicated in the preamble of the appending claim 1. According to another aspect, the invention also refers to an oven having a temperature probe and defined in the preamble of  
5 claim 3.

In domestic ovens it is common to use a temperature probe in order to sense the temperature of the foodstuff to be treated in the oven for the purpose of improving the control of the course of treatment. The probe is inserted in a piece of meat  
10 or a poultry, for example, so that the temperature sensor, which is usually disposed at the tip of the probe, will be placed essentially in the center of the piece of meat or in the center of the fleshy part of the poultry. It is namely important for the result that the lowest temperature in the food-  
15 stuff is to control the treatment.

In practice, often the tip of the probe does not end up at the point of lowest temperature but at the side of said point. As a result, meat and poultry needed to be cooked all trough will not have the proper treatment because the oven, controlled  
20 by the temperature probe, will be prematurely switched off.

In the Japanese patent application No. 58-99623 a microwave oven is disclosed which is provided with a temperature probe. In the application it is noticed that if poultry is being treated in such oven its surface tends to become scorched while  
25 the interior of the poultry still has a condition close to raw. In order to remedy this drawback it is suggested to provide the temperature probe with an additional sensor which is disposed so that when the probe is inserted in the poultry the sensor at the tip of the probe is positioned in the center of the fleshy  
30 part of the poultry while the additional sensor is positioned adjacent to the surface of the poultry. Then, the treatment is controlled by means of the temperature values from the two sensors so that the interior of the poultry reaches the desired temperature at the same time as does the surface of the

poultry. Further, it is established that from a theoretic point of view an even finer heating control can be achieved by the number of sensors being increased. In such case, however, the complexity of the control device and of the probe with its connectors increases and for cost reasons the application with two sensors has been found rational.

The known temperature probe is intended for use together with a microwave oven and then for the control of the energy supply for the purpose of the desired temperature to be reached simultaneously inside a piece of meat and at the surface of said piece of meat. The supply of energy is controlled in accordance with a predetermined program with the use of the temperature values from the two sensors.

In an oven, heated in a traditional way, i.e. an oven provided with heating elements or a hot air fan, a temperature probe of a conventional design, will frequently end up at the wrong position inside a piece of meat, or the like, to be treated. Accordingly, it is of interest to make use of the technique described above of providing additional sensors in the probe in order to increase the chances that at least one of the sensors takes the position of lowest temperature in said piece of meat. Of course, as suggested in the publication referred to, it is possible to provide several sensors in the probe but for the reasons given above this will lead to a situation where the construction of the probe, of the connecting parts and of the control device for the energy supply will become complicated. A reasonable compromise between the desired degree of fine regulation and the cost leads to a probe having three sensors and being provided with a connector of the telephone plug type having three contact areas (stereophonic audio plug).

The object of the invention is to provide a temperature probe of the kind referred to above which makes possible for the sensed temperature, as far as possible, to equal the lowest temperature of a piece of meat, or the like, to be treated. Another object of the invention is to provide for controlled energy supply to an oven in accordance with the lowest temperature thus measured. The objects indicated will be achieved by a temperature probe having the characterizing features in-

licated in claim 1 and by an oven having the characterizing features indicated in claim 3-10.

The invention will now be described more in detail in connection with an embodiment with reference to the enclosed drawings, in which:

- Fig. 1 shows a temperature probe with associated connector,
- Fig. 2A and 2B show alternative interconnecting arrangements for three sensors, and
- 10 Fig. 3, finally, schematically shows an oven with a temperature probe connected thereto and with a control device for the supply of energy.

In Fig. 1 a temperature probe 10 is shown which is designed in accordance with the invention. In the conventional way, the probe comprises an elongate tubular part 11 one end of which being attached to a handle 12 whereas the opposite end is provided with a tip intended to facilitate the insertion of the probe into a foodstuff the temperature of which is to be monitored. A temperature sensor 13 is disposed at the tip and another two sensors 14,15 of the same type are provided along the tubular part 11. These sensors are resistors the resistance of which depends on temperature, referred to as thermistors. Each of the thermistors is disposed in the tubular part or housing so as to be electrically insulated from said part. In addition, each thermistor has two connecting terminals which by suitable conductors, not shown, in a cable 16 are connected to three contact areas 17,18,19 disposed on a connector 20 of the telephone plug type.

In this case, where three thermistors are present, these can be connected in Y-connection as shown in Fig. 2A. The thermistors have been designated  $R_1$ ,  $R_2$  and  $R_3$  and are connected between the respective terminal 21,22,23 and a common point O. If there is a desire for a direct measurement of the resistance of the respective thermistor this can be performed by a measurement between the respective terminal and the common point O. However, such a measurement would require an additional conductive area on the connector which leads to a special design of said connector. The aim is to use, as far as possible, standard components and the connector 20 shown in

Fig. 1 is such a component in the shape of a telephone plug of a stereophonic design used in audio applications. The connector offers three contact areas only which means that with the thermistors connected in Y-connection, as shown in fig. 2A, measurement can only take place between the terminals 21-23, 21-22 and 22-23, respectively. The resistances measured are designated  $R_a$ ,  $R_b$  AND  $R_c$ . From the circuit diagram it appears that  $R_a$  is determined by  $R_1$  in series with  $R_3$  while, correspondingly,  $R_b$  is determined by  $R_1$  in series with  $R_2$  and  $R_c$  is determined by  $R_2$  in series with  $R_3$ . With the designations given three mathematic formulas can be set up between  $R_a$ ,  $R_b$  and  $R_c$ , respectively, and the three resistance values  $R_1$ ,  $R_2$  and  $R_3$  and a certain amount of calculation leads to the following formulas for the three resistances  $R_1$ ,  $R_2$  and  $R_3$  as expressed in the three measured resistances  $R_a$ ,  $R_b$  and  $R_c$ :

$$R_1 = \frac{1}{2}(R_a + R_b - R_c) \quad R_2 = \frac{1}{2}(R_b + R_c - R_a) \quad R_3 = \frac{1}{2}(R_a - R_b + R_c)$$

An alternative connection of the three thermistors is shown in Fig. 2B according to which the thermistors have been connected so as to form a triangle. Here, the resistances have been designated  $R_4$ ,  $R_5$  and  $R_6$  whereas the corresponding terminals have been designated 24, 25 and 26. The resistance values measured between the terminals 24-26, 24-25 and 25-26, respectively, have been designated  $R_d$ ,  $R_e$  and  $R_f$ . In this variant of connection the resistances  $R_4$ ,  $R_5$  and  $R_6$  and the measured resistances are so correlated that a much more difficult calculation work is required in determining the resistance of the respective thermistor than is the case in the connection according to Fig. 2A. In this case the simplest way is to use the known formulas for transfer from triangle connection to Y-connection in order first to transform the coupling to star shape and thereafter to use the formulas presented in connection with Fig. 2A for determining the resistance of the respective thermistor and of the temperatures represented by said resistance values.

In the first place, the temperature probe is intended to be used in a domestic oven and such an oven is shown schematically in Fig. 3. The tip of the probe has been inserted into a piece of meat 27 so that the three sensors will take somewhat

different positions in the piece of meat, this in order for the point of lowest temperature in the piece of meat to be more easily determined. The distance between the sensors is chosen with this desire in mind and in the practical case the distance can be in the range of 1-3 centimetres. The connector 20 is connected to an outlet of a corresponding design, here referred to as a telephone jack disposed in the inner wall of said oven. The oven, designated by 28, is in the conventional way provided with heating elements 29,30 disposed in the upper and lower part, respectively, of the oven compartment, referred to by 31.

In order to control the supply of heat from the two heating elements in the oven a control device 32 is provided which conveniently comprises a microprocessor for the necessary resistance calculations to be performed. The setting of temperature and the choice of heating mode, such as bottom heat, top heat, both top heat and bottom heat, can be performed by means of suitable knobs 33. By carrying out the described measurements and then the calculations indicated the temperatures sensed by the thermistors can be determined. Then, in accordance with the invention, the oven is controlled according to the lowest of said temperature values. This means that when the temperature set has been reached in the present piece of meat, one knows with greater certainty than before that in no point in said piece of meat a lower temperature is prevailing.

By the temperature probe described it will be possible to insert same into a piece of meat, a poultry or the like without the requirement for the tip of the probe to be disposed in the exactly correct position, namely in the center of the piece of meat or the fleshy part of the poultry, which position is considered to be the latest one to reach the desired temperature. In addition, by controlling the oven according to the lowest of the sensed temperatures, the desired temperature will always be achieved in every point of the piece of meat or the poultry with greater certainty than before.

## C l a i m s

1. Temperature probe intended to be inserted into a foodstuff to be heated, the temperature probe (10) having the shape of a rod and supporting, at its tip and at at least one additional position, a temperature sensor (13,14,15) of a type the  
5 resistance of which varies with the temperature, the temperature probe via a wire (16) being connected to a connector (20) of the telephone plug type which, via a corresponding jack disposed in an oven (28) provided for the heating treatment, is connectable to a control device (32) for the control of the  
10 heating process, **characterized** in that three temperature sensors (13,14,15) are provided to be supported by the probe (10) at positions suitably interspaced with respect to one another, the connector (20) having three contact areas (17,18,19) and the three temperature sensors (13,14,15) being  
15 connected to form a star or a triangle with the three terminals thus formed being connected to the respective contact area of the connector.
2. Temperature probe according to claim 1, **characterized** in that the space between the temperature sensors is in the range  
20 of 1-3 centimetres.
3. Oven for treatment of foodstuffs, comprising a temperature probe (10) intended to be inserted into a foodstuff (27) to be heated, the temperature probe having the shape of a rod and, at its tip and at least one additional position along its length,  
25 supporting a temperature sensor (13,14,15), the temperature probe (10) being connectable to a control device (32) for the control of the treatment process in the oven (28), **characterized** in that as a total at least three temperature sensors (13,14,15) are provided in the probe (10) suitably interspaced  
30 with respect to one another, the control device (32) being arranged to control the treatment process based on the lowest one of the temperatures sensed by the sensors.
4. Oven according to claim 3, **characterized** in that the space between the temperature sensors is in the range of 1-3 centi-  
35 metres.
5. Oven according to claim 3, **characterized** in that the temperature sensors (13,14,15) are of the type the resistance



of which varies with the temperature, the resistance of the sensors being in essentially the same range and, further, each sensor being connected to the control device (32) via a suitable connector (20), said control device being arranged to  
5 determine the resistance value that corresponds to the lowest temperature value by comparison of the sensed resistance values.

6. Oven according to claim 5, **characterized** in that three sensors (13,14,15) are provided and connected to form a star,  
10 the three connecting points (21,22,23) formed by the free ends of the sensors being connected to its respective contact area (17,18,19) on a connector (20) of a standardized design of the telephone plug type.

7. Oven according to claim 5, **characterized** in that three  
15 sensors (13,14,15) are provided and connected to form a triangle, the three connecting points (24,25,26) being connected to each respective contact area (17,18,19) on a connector (20), said control device (32) being arranged to perform, by means of known transfer formulas, a transform of the triangle  
20 connection to a star connection in order to determine the resistance values of the different sensors.

8. Oven according to claim 7, **characterized** in that the three connecting points (24,25,26) are connected to each respective contact area (17,18,19) of a connector (20) in a standardized  
25 form of the telephone plug type.

9. Oven according to any of the preceding claims, **characterized** in that the control device (32) comprises a microprocessor.

10. Oven according to any of the preceding claims, **characterized**  
30 **terized** in that the oven (28) is arranged to be heated by means of thermal energy.

1/1

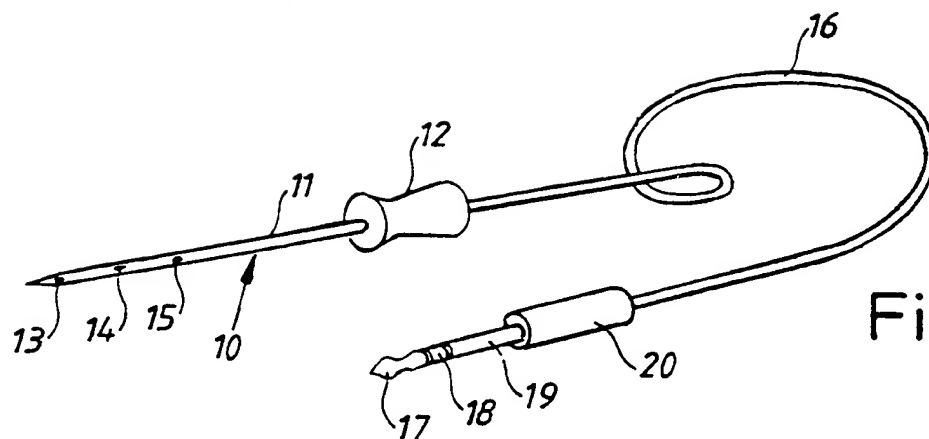


Fig. 1

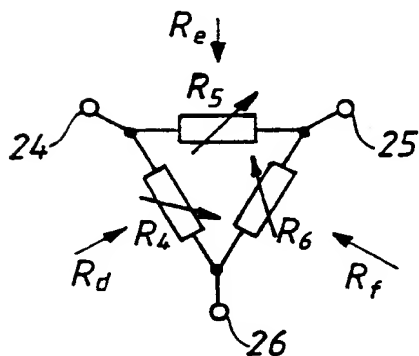


Fig. 2b

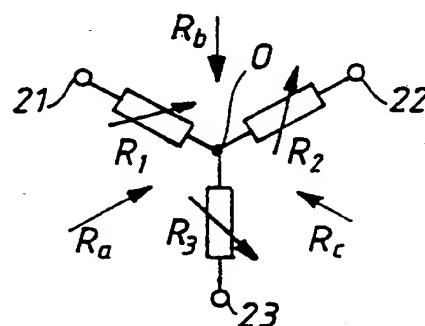


Fig. 2a

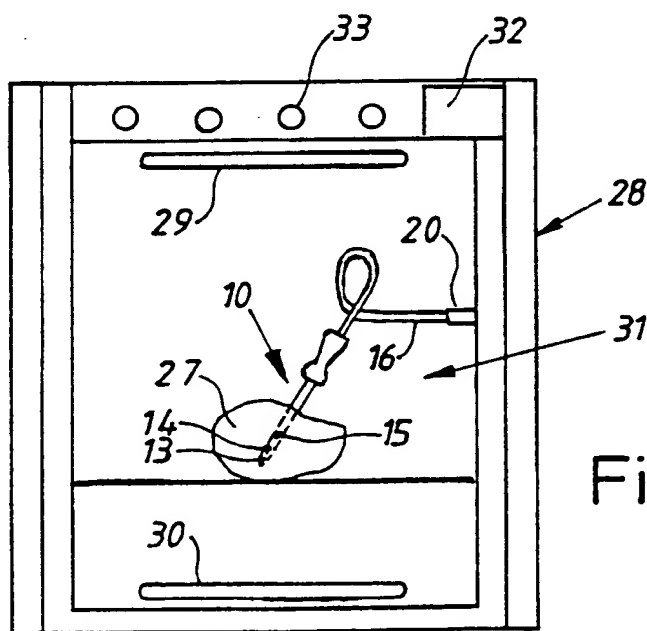


Fig. 3

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 93/00046

## A. CLASSIFICATION OF SUBJECT MATTER

IPC5: F24C 7/08, G01K 1/00, G01K 13/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: F24C, G01K, H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
|-----------|---|-----------------------|
| A         | Patent Abstracts of Japan, Vol 6, No 76, M-128,<br>abstract of JP, A, 57-16729 (MATSUSHITA DENKI<br>SANGYO K.K.), 28 January 1982 (28.01.82)<br>--  | 1,3                   |
| A         | Patent Abstracts of Japan, Vol 12, No 302, M-732,<br>abstract of JP, A, 63-75419 (MATSUSHITA ELECTRIC<br>IND CO LTD), 5 April 1988 (05.04.88)<br>-- | 1,3                   |
| A         | Patent Abstracts of Japan, Vol 7, No 179, M-234,<br>abstract of JP, A, 58-83132 (MATSUSHITA DENKI<br>SANGYO K.K.), 18 May 1983 (18.05.83)<br>--     | 1,3                   |

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"B" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

21 April 1993

Date of mailing of the international search report

11 -05- 1993

Name and mailing address of the ISA/  
Swedish Patent Office  
Box 5055, S-102 42 STOCKHOLM  
Facsimile No. +46 8 666 02 86

Authorized officer

Lars Jakobsson  
Telephone No. +46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 93/00046

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
|-----------|--|-----------------------|
| A         | Patent Abstracts of Japan, Vol 7, No 199, M-240, abstract of JP, A, 58-99623 (MATSUSHITA DENKI SANGYO K.K.), 14 June 1983 (14.06.83), cited in the application<br>-- | 1,3                   |
| A         | US, A, 4081645 (W.R. JAVES ET AL), 28 March 1978 (28.03.78), column 3, line 61 - column 4, line 38, figure 5<br>--   | 1,3                   |
| A         | US, A, 4122322 (MASARU OHKUBO ET AL), 24 October 1978 (24.10.78), figures 1-7, abstract<br>--  | 1,3                   |
| A         | US, A, 4291576 (KENNETH E. DEANE), 29 Sept 1981 (29.09.81), figures 1-3, abstract<br>--  | 1,3                   |
| A         | US, A, 4415790 (BRADFORD J. DIESCH ET AL), 15 November 1983 (15.11.83), figure 1, abstract<br>--   | 1,3                   |
| A         | US, A, 4294116 (KEIZO YAMAMURA ET AL), 13 October 1981 (13.10.81), figure 1, abstract<br>-----<br>--   | 1                     |

## INTERNATIONAL SEARCH REPORT

Information on patent family members

31/03/93

International application No.

PCT/SE 93/00046

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                      | Publication<br>date                          |
|---|---------------------|---|--|
| US-A- 4081645                             | 28/03/78            | NONE  |  |
| US-A- 4122322                             | 24/10/78            | AU-B- 504355<br>AU-A- 2714877<br>CA-A- 1061135<br>GB-A- 1548805 | 11/10/79<br>25/01/79<br>28/08/79<br>18/07/79 |
| US-A- 4291576                             | 29/09/81            | NONE  |  |
| US-A- 4415790                             | 15/11/83            | NONE  |  |
| US-A- 4294116                             | 13/10/81            | NONE  |  |

